

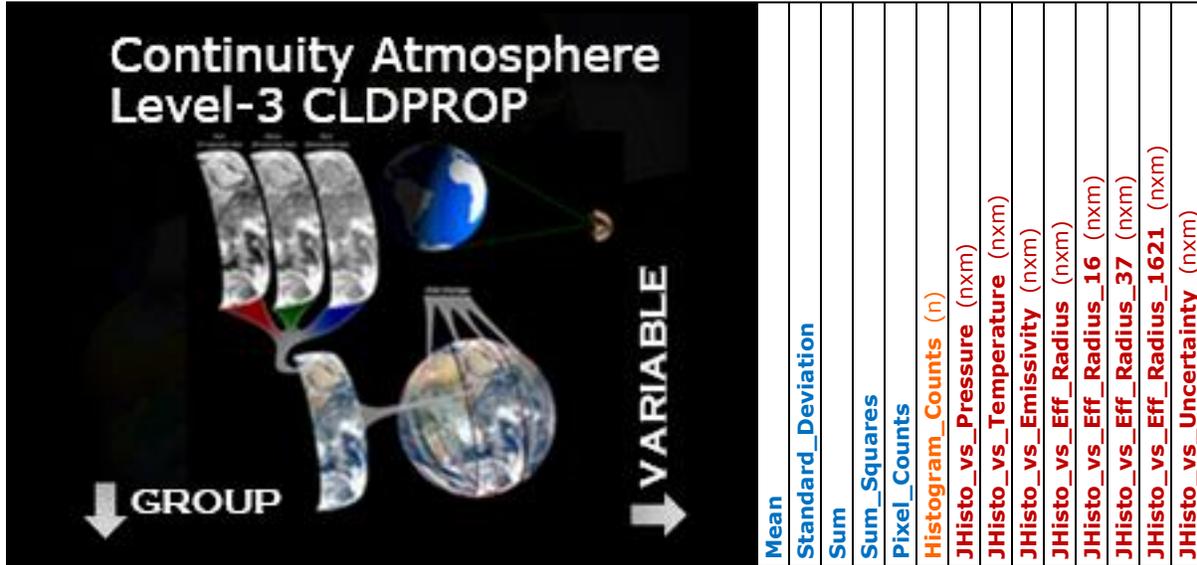
Level-3 CLDPROP

Inventory of Groups & Variables

File Version 011 Data Version v1.1

Pre-Yori Delivery v1.1.2 Run with Yori v1.3.9

Groups (Parameters)=127, Variables (Stats)=837 (Scalar=630, H=68, JH=129)



Solar and Sensor Angles (4)

01. Solar_Zenith (Masked w. Cloud Mask Day Flag ($\leq 85^\circ$) to match MODIS L3)	•	•	•	•	•																
02. Solar_Azimuth (Masked w. Cloud Mask Day Flag)	•	•	•	•	•																
03. Sensor_Zenith (Masked w. Cloud Mask Day Flag) Masked All: VZA LE 65.5°	•	•	•	•	•																
04. Sensor_Azimuth (Masked w. Cloud Mask Day Flag)	•	•	•	•	•																

Cloud Top Properties (CTP) (21) JH=21

[CTP 06_L2 Algo Day: SZA $\leq 85^\circ$] [New CTP CLDPROP Algo Day: SZA $\leq 80^\circ$]

01. Cloud_Top_Pressure	•	•	•	•	•	•	•														•	
02. Cloud_Top_Pressure_Day	•	•	•	•	•	•	•															•
03. Cloud_Top_Pressure_Night	•	•	•	•	•	•	•															•
04. Cloud_Top_Temperature ¹	•	•	•	•	•	•	•	•														•
05. Cloud_Top_Temperature_Day ¹	•	•	•	•	•	•	•	•														•
06. Cloud_Top_Temperature_Night ¹	•	•	•	•	•	•	•	•														•
07. Cloud_Top_Height ¹	•	•	•	•	•	•	•	•														•
08. Cloud_Top_Height_Day ¹	•	•	•	•	•	•	•	•														•
09. Cloud_Top_Height_Night ¹	•	•	•	•	•	•	•	•														•
10. Cloud_Effective_Emissivity ¹	•	•	•	•	•	•	•	•														
11. Cloud_Effective_Emissivity_Day ¹	•	•	•	•	•	•	•	•														
12. Cloud_Effective_Emissivity_Night ¹	•	•	•	•	•	•	•	•														

Continuity Atmosphere Level-3 CLDPROP															
		Mean	Standard_Deviation	Sum	Sum_Squares	Pixel_Counts	Histogram_Counts (n)	JHisto_vs_Pressure (nxm)	JHisto_vs_Temperature (nxm)	JHisto_vs_Emissivity (nxm)	JHisto_vs_Eff_Radius (nxm)	JHisto_vs_Eff_Radius_16 (nxm)	JHisto_vs_Eff_Radius_37 (nxm)	JHisto_vs_Eff_Radius_1621 (nxm)	JHisto_vs_Uncertainty (nxm)
13. Cloud_Fraction [Computed from Cloud_Mask_Cloudiness]		•	•	•	•	•									
14. Cloud_Fraction_Day [Cloud Mask Algo Day: SZA ≤ 85°]		•	•	•	•	•									
15. Cloud_Fraction_Night [Cloud Mask Algo Night: SZA > 85°]		•	•	•	•	•									
16. Cloud_Mask [4 cats: Conf.Cldy, Prob.Cldy, Prob.Clr, Conf.Clr] Det.=1							•								
17. Cloud_Mask_Day [4 cats: Conf.Cldy, Prob.Cldy, Prob.Clr, Conf.Clr] Det.=1							•								
18. Cloud_Mask_Night [4 cats: Conf.Cldy, Prob.Cldy, Prob.Clr, Conf.Clr] Det.=1							•								
19. CTP_Phase [5 cats: Clear, Liq.Water, Ice, Mixed, Undet.] Note: Mix & Undet = 0							•								
20. CTP_Phase_Day [5 cats: Clear, Liq.Water, Ice, Mixed, Und.]							•								
21. CTP_Phase_Night [5 cats: Clear, Liq.Water, Ice, Mixed, Und.]							•								

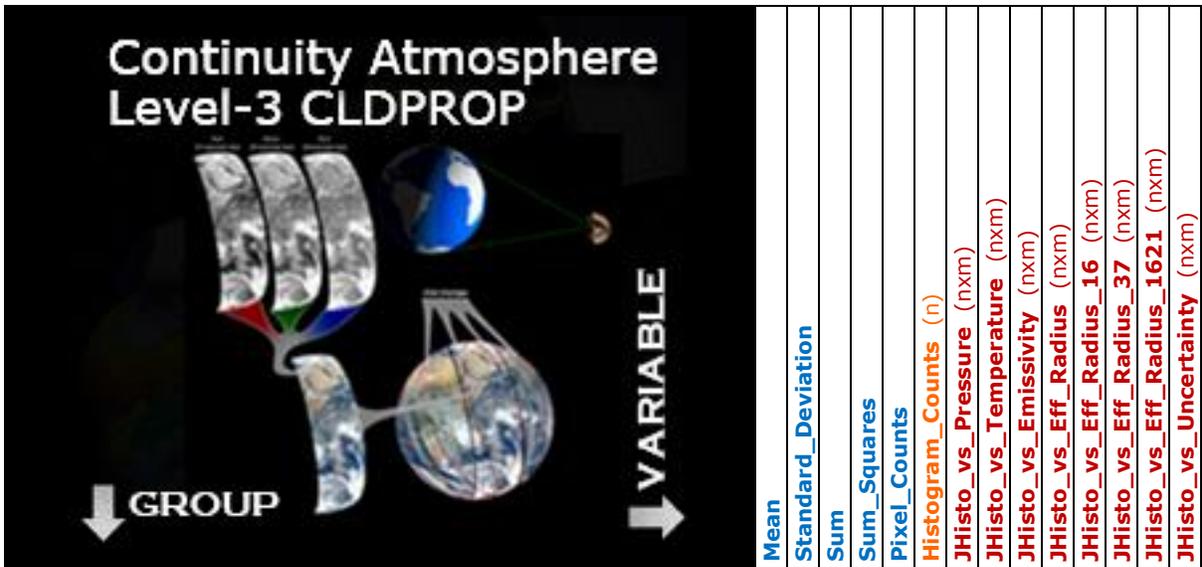
Cloud Optical Properties (COP) (103) JH=105

(Primary 2.1 μm Retrieval) (43) JH=37

[COP 06_L2 Algo: SZA ≤ 81.3731°] [New COP CLDPROP Algo: SZA ≤ 80°]

01. Cloud_Optical_Thickness_Liquid	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
02. Cloud_Optical_Thickness_Ice	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
03. Cloud_Optical_Thickness_Undetermined	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
04. Cloud_Optical_Thickness_Combined	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
05. Cloud_Optical_Thickness_ISCCP								•							
06. Cloud_Optical_Thickness_Log_Liquid	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
07. Cloud_Optical_Thickness_Log_Ice	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
08. Cloud_Optical_Thickness_Log_Undetermined	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
09. Cloud_Optical_Thickness_Log_Combined	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
10. Cloud_Optical_Thickness_PCL_Liquid	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
11. Cloud_Optical_Thickness_PCL_Ice	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
12. Cloud_Optical_Thickness_PCL_Undetermined	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
13. Cloud_Optical_Thickness_PCL_Combined	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•

Continuity Atmosphere Level-3 CLDPROP															
		Mean	Standard_Deviation	Sum	Sum_Squares	Pixel_Counts	Histogram_Counts (n)	JHisto_vs_Pressure (nxm)	JHisto_vs_Temperature (nxm)	JHisto_vs_Emissivity (nxm)	JHisto_vs_Eff_Radius (nxm)	JHisto_vs_Eff_Radius_16 (nxm)	JHisto_vs_Eff_Radius_37 (nxm)	JHisto_vs_Eff_Radius_1621 (nxm)	JHisto_vs_Uncertainty (nxm)
14.	Cloud_Optical_Thickness_PCL_ISCCP							•							
15.	Cloud_Optical_Thickness_PCL_Log_Liquid	•	•	•	•	•									
16.	Cloud_Optical_Thickness_PCL_Log_Ice	•	•	•	•	•									
17.	Cloud_Optical_Thickness_PCL_Log_Undetermined	•	•	•	•	•									
18.	Cloud_Optical_Thickness_PCL_Log_Combined	•	•	•	•	•									
19.	Cloud_Effective_Radius_Liquid	•	•	•	•	•	•	•	•					•	
20.	Cloud_Effective_Radius_Ice	•	•	•	•	•	•	•	•					•	
21.	Cloud_Effective_Radius_Undetermined	•	•	•	•	•	•								
22.	Cloud_Effective_Radius_PCL_Liquid	•	•	•	•	•	•	•	•					•	
23.	Cloud_Effective_Radius_PCL_Ice	•	•	•	•	•	•	•	•					•	
24.	Cloud_Effective_Radius_PCL_Undetermined	•	•	•	•	•	•								
25.	Cloud_Water_Path_Liquid [Range: 0 to 3000]	•	•	•	•	•	•							•	
26.	Cloud_Water_Path_Ice [Range: 0 to 6000]	•	•	•	•	•	•							•	
27.	Cloud_Water_Path_Undetermined	•	•	•	•	•	•								
28.	Cloud_Water_Path_PCL_Liquid	•	•	•	•	•	•							•	
29.	Cloud_Water_Path_PCL_Ice	•	•	•	•	•	•							•	
30.	Cloud_Water_Path_PCL_Undetermined	•	•	•	•	•	•								
31.	Cloud_Retrieval_Fraction_Liquid (COPR_LIQ derived)	•	•	•	•	•									
32.	Cloud_Retrieval_Fraction_Ice	•	•	•	•	•									
33.	Cloud_Retrieval_Fraction_Undetermined	•	•	•	•	•									
34.	Cloud_Retrieval_Fraction_Combined	•	•	•	•	•									
35.	Cloud_Retrieval_Fraction_PCL_Liquid (COPR_PCL_LIQ)	•	•	•	•	•									
36.	Cloud_Retrieval_Fraction_PCL_Ice	•	•	•	•	•									
37.	Cloud_Retrieval_Fraction_PCL_Undetermined	•	•	•	•	•									
38.	Cloud_Retrieval_Fraction_PCL_Combined	•	•	•	•	•									



	Mean	Standard_Deviation	Sum	Sum_Squares	Pixel_Counts	Histogram_Counts (n)	JHisto_vs_Pressure (nxm)	JHisto_vs_Temperature (nxm)	JHisto_vs_Emissivity (nxm)	JHisto_vs_Eff_Radius (nxm)	JHisto_vs_Eff_Radius_16 (nxm)	JHisto_vs_Eff_Radius_37 (nxm)	JHisto_vs_Eff_Radius_1621 (nxm)	JHisto_vs_Uncertainty (nxm)
[Note: L2 Re < 4.0 has no Impact on 37 through 39, since they're Success + Fail]														
39. Cloud_Phase_Optical_Properties [L, I, U] [Cld+PCL] [S+F]							•							
40. COP_Phase_Cloudy [3 cats: Liq, Ice, Undet] CSR=0 [Succ+Fail]						•								
41. COP_Phase_Partly_Cloudy [3 cats: Liq, Ice, Undet] CSR=1,3 [S+F]						•								
42. COP_Phase_CloudMaskClear [1 cat: CloudMaskClear] CSR=0						•								
43. COP_Phase_RestoredToClear [1 cat: RestoredToClear] CSR=2						•								

(Supplementary 1.6 μm Retrieval) (20) JH=28

01. Cloud_Optical_Thickness_16_Liquid	•	•	•	•	•	•				•				•
02. Cloud_Optical_Thickness_16_Ice	•	•	•	•	•	•				•				•
03. Cloud_Optical_Thickness_16_Log_Liquid	•	•	•	•	•									
04. Cloud_Optical_Thickness_16_Log_Ice	•	•	•	•	•									
05. Cloud_Optical_Thickness_16_PCL_Liquid	•	•	•	•	•	•				•				•
06. Cloud_Optical_Thickness_16_PCL_Ice	•	•	•	•	•	•				•				•
07. Cloud_Optical_Thickness_16_PCL_Log_Liquid	•	•	•	•	•									
08. Cloud_Optical_Thickness_16_PCL_Log_Ice	•	•	•	•	•									
09. Cloud_Effective_Radius_16_Liquid	•	•	•	•	•	•	•	•	•	•	•	•	•	•
10. Cloud_Effective_Radius_16_Ice	•	•	•	•	•	•	•	•	•	•	•	•	•	•
11. Cloud_Effective_Radius_16_PCL_Liquid	•	•	•	•	•	•	•	•	•	•	•	•	•	•
12. Cloud_Effective_Radius_16_PCL_Ice	•	•	•	•	•	•	•	•	•	•	•	•	•	•
13. Cloud_Water_Path_16_Liquid	•	•	•	•	•	•								•
14. Cloud_Water_Path_16_Ice	•	•	•	•	•	•								•
15. Cloud_Water_Path_16_PCL_Liquid	•	•	•	•	•	•								•
16. Cloud_Water_Path_16_PCL_Ice	•	•	•	•	•	•								•
17. Cloud_Retrieval_Fraction_16_Liquid	•	•	•	•	•									
18. Cloud_Retrieval_Fraction_16_Ice	•	•	•	•	•									
19. Cloud_Retrieval_Fraction_16_PCL_Liquid	•	•	•	•	•									
20. Cloud_Retrieval_Fraction_16_PCL_Ice	•	•	•	•	•									

Continuity Atmosphere Level-3 CLDPROP															
↓ GROUP		↑ VARIABLE													
		Mean	Standard_Deviation	Sum	Sum_Squares	Pixel_Counts	Histogram_Counts (n)	JHisto_vs_Pressure (nxm)	JHisto_vs_Temperature (nxm)	JHisto_vs_Emissivity (nxm)	JHisto_vs_Eff_Radius (nxm)	JHisto_vs_Eff_Radius_16 (nxm)	JHisto_vs_Eff_Radius_37 (nxm)	JHisto_vs_Eff_Radius_1621 (nxm)	JHisto_vs_Uncertainty (nxm)
05.	Cloud_Optical_Thickness_1621_PCL_Liquid	•	•	•	•	•	•							•	•
06.	Cloud_Optical_Thickness_1621_PCL_Ice	•	•	•	•	•	•							•	•
07.	Cloud_Optical_Thickness_1621_PCL_Log_Liquid	•	•	•	•	•									
08.	Cloud_Optical_Thickness_1621_PCL_Log_Ice	•	•	•	•	•									
09.	Cloud_Effective_Radius_1621_Liquid	•	•	•	•	•	•								•
10.	Cloud_Effective_Radius_1621_Ice	•	•	•	•	•	•								•
11.	Cloud_Effective_Radius_1621_PCL_Liquid	•	•	•	•	•	•								•
12.	Cloud_Effective_Radius_1621_PCL_Ice	•	•	•	•	•	•								•
13.	Cloud_Water_Path_1621_Liquid	•	•	•	•	•	•								•
14.	Cloud_Water_Path_1621_Ice	•	•	•	•	•	•								•
15.	Cloud_Water_Path_1621_PCL_Liquid	•	•	•	•	•	•								•
16.	Cloud_Water_Path_1621_PCL_Ice	•	•	•	•	•	•								•
17.	Cloud_Retrieval_Fraction_1621_Liquid	•	•	•	•	•									
18.	Cloud_Retrieval_Fraction_1621_Ice	•	•	•	•	•									
19.	Cloud_Retrieval_Fraction_1621_PCL_Liquid	•	•	•	•	•									
20.	Cloud_Retrieval_Fraction_1621_PCL_Ice	•	•	•	•	•									

Orange Shading = Late Additions (Aug 2019) Histogram_Counts.

Green Shading = The Cloud Retrieval Fraction Groups.

Orange Text = Orange Text used for certain parameters such as **Cloud_Mask** or **CTP_Phase** denote histograms of QA Flags that can be used to post process fraction statistics or get other types of counts.

Green Text = Green Text used to help differentiate LOG Statistics.

New Mask #1 (implemented 6/13/19) = The COP Liq, Undet, and Combined parameters were masked for CER being out of range, that is outside the expected 4.0 to 60.0 range. The need for this mask in L3 was due to a L2 CLDPROP code bug that caused the CER Liquid (or Undetermined Phase) values to very occasionally drop into the invalid range of 2.0 to 3.999. It was decided to screen these bad L2 values out of L3. This was done through a

masking dataset called Mask_Valid_Range_CER* that is applied in the YAML file. If in future Collections/Versions should it be desired to remove this mask, simply remove the Mask_Valid_Range_CER* mask from each of the YAML file entries. Note that the masks had to be computed and tagged for the flavor of retrieval (21, 16, 37, or 1621) as well as Regular Cloudy or PCL. The mask can then be applied to all cloud phases since it's a combined phase valid range (4.0 to 60.0). In the latest version of the L3 code, the mask was only applied to Liquid, Undetermined, and Combined Phase parameters (since the L2 CER Ice had no valid range issue).

New Mase #2 Customized (implemented 6/13/19) = Note that Mask #1, outlined above, could NOT be applied to any of the Cloud_Retrieval_Fractions since that mask would also effectively wipe out the CLEARs or FALSE from the COPR intermediate Pre-Yori arrays. So for the CRF arrays, the bad L2 data screening had to be done directly in the Pre-Yori code. This is an important fact to remember should the valid range ever change for CER in later Collections/Versions. With the current modification, no L2 pixel with a CER between 2.0 and 3.999 will get into the numerator (success) of the Cloud Retrieval Fraction computation.

Note that for the **JHisto_vs_Uncertainty** arrays, the Uncertainty will be in relative (%) units. This will require post processing to compute the actual uncertainty in each L3 1x1 degree grid. (Note that for Cloud Top Properties, the uncertainty is computed directly for Cloud_Top_Temperature only. For Cloud Optical Properties, the uncertainty is computed directly for Cloud_Optical_Thickness and Cloud_Effective_Radius only. For other parameters not listed here, the uncertainties are derived. For example Cloud_Top_Pressure, Cloud_Top_Height, Cloud_Water_Path have derived uncertainties.

Programming Notes:

Note 1: Computing the actual L3 1x1 deg. grid uncertainties will require an additional programming enhancement in YORI, which is not currently coded (available). To work around this shortcoming in YORI, Joint Histograms of Primary Parameter vs. Uncertainty were created. Relative Uncertainty (%) instead of Absolute Uncertainty were used in these new JH's for 2 reasons: 1.) it allows for a consistent set of Uncertainty JH Bin Boundaries to be used across all parameters streamlining the unpacking and interpretation by users, and 2.) it allows for a much faster operational run time in the Pre-Yori step. These relative uncertainties would then need to be post processed (converting the uncertainties from relative (%) to absolute) and run through a more complicated equation at the 1x1 degree L3 grid level. Details will be provided in a L3 VNPCLDPROP Users Guide to be written. The first-cut bin boundaries for the Uncertainty Axis in percent are: [0, 2, 4, 6, 8, 10, 12, 15, 20, 25, 30, 35, 40, 45, 50, 60, 70, 80, 90, 100, 150, 200]. These will be used for all the JHisto_vs_Uncertainty arrays. The 150 boundary may be dropped after a few sample output JH's are studied to see how much action there is above 100.

Note 2: Made a request of UW to modify YORI to initialize the sum, sum_squares, and n_points statistics with fills instead of zeros – this modification is needed so we can differentiate between missing data (orbital gaps, missing scanlines) and 0 count data (instrument data was there, but the condition was not met) in L3 data and imagery. Change Request was completed on 8/15/18 and is in YORI v1.2.5

Note 3: Log statistics have to be preprocessed to exist in the interim (temporary) file before processing through YORI. YORI cannot produce Log Stats on the fly (at least not in the current YORI version), but have to be fed in directly from L2. This was completed on 8/18/18.

Note 4: There is no 1L and ML aggregation in CLDPROP, it's impossible to do MODIS-style multilayer cloud detection with VIIRS.

Note 5: I asked the UW Yori team if they could automatically pass the "long_name" and "units" group attributes to the local attributes of the mean variable. This was requested so the output L3 VIIRS files play nicer with Panoply. Panoply will only read titles and units from a variables local attribute and will not query the group attributes. I asked for mean only since that is the statistic that will be visualized in 95% of the cases and to make the modification job needed by the YORI team easier.

Note 6: I asked the UW Yori team if they could increase the local attributes for the histogram and joint histogram. I would like the edges or bin boundaries to be included in the local attributes.

Note 7. A note related to the Cloud_Mask flags -- the internal documentation for Cloud Mask (Unobstructed FOV Flag) states that Flag=1 means "Uncertain" (it's documented this way both in MODIS 35_L2 and 06_L2, as well as in VIIRS L2 VNPCLDPROP); Rich Frey at UW confirmed with me in August 2018 that Flag=1 should mean "Probably Cloudy" and not "Uncertain". "Uncertain" is too nebulous and ill-defined. Further, it was confirmed that the equation to compute Cloud_Fraction (from Cloud Mask) has not changed at any time during the MODIS data record: To compute Cloud Fraction from Cloud Mask, users should sum the counts in the first two histogram bins (confident cloudy and probably cloudy) and tag that cloudy and sum the last two histogram bins (probably clear and confident clear) and tag that as clear; then compute the fraction.

Note 8: L3 Code needs to be retested after removing patches for bad L2 data in earlier L2 algorithm versions. Earlier versions of the L2 code had a mismatch between the _FillValue local attribute and the actual fill value used in the data, which required software patching in the Pre-Yori code.

Note 9. Steve P. noted that we'd like to have a way NOT to pass the Uncertainty Joint Histograms to the Monthly file. However currently in the SIPS/YORI system there is not a way to intervene between D3 and M3 – everything is passed through automatically.

Note 10. The Fraction is computed (slyly) in YORI, by running a sampled field of True/False through the Mean computation. Note that the Sum and Pixel_Counts are used to continuously to recompute the Fraction (Mean) as you go to new temporal domains. The Sum_Squares will be identical to Sum (since 0 and 1 squared are 0 and 1) – so that stat adds no new information. I am not sure about the meaning of Standard_Deviation – that would be the stddev of the 0s and 1s in the sampled PreYori file. More thought is needed.

Note 11. It's impossible to do a Cloud_Fraction JHisto_vs_Pressure as was done in MOD08-MODIS because I do not have Fractions computed at L2 for CLDPROP as I did for MOD06_MODIS. The Fraction for CLDPROP_VIIRS is not actually computed until L3. For CLDPROP, in L2, it's simply a field of 0.0's (false) and 1.0's (true) and I don't think it makes much sense to do a JHisto of those 0s and 1s vs Pressure in a JHisto.

Note 12. The Day/Night separation in CLDPROP L3 is based on the L2 Cloud_Mask QA Day/Night Flag. Note that this Day/Night Flag is using Solar Zenith Angle LE 85 degrees as a daytime cutoff. However for the Cloud Top Properties algorithm, that daytime cutoff was changed to 80 degrees. For Cloud_Optical_Properties that was initially set to 81.3731 degrees, however by November 2018, there was discussion to change that to 80.0 degrees to match the Cloud Top Properties Algorithm. We'd eventually like the Cloud Mask people to change their Cloud_Mask QA in L2 CLDPROP to match Cloud Top Properties and have daytime be defined at SZA LE 80 (however I don't believe there was any formal plan for doing that in the L2 CLDPROP file. This means as long as L3 CLDPROP is using the Cloud_Mask QA Day/Night flag cutoff of 85 degrees. Some of the Cloud Top Properties Daytime Groups will have some "nighttime" data mixed in at the day/night boundary.

Note 13. The Pixel Counts for the Cloud Retrieval Fraction stats will be the denominator (cldy + clear) since it's the valid count of the set up array of 1's and 0's. For the MODIS Standard, the fractions were computed in the Tiling Code itself which allowed us to select the numerator of that calculation for Pixel Counts. So the Pixel Counts for the Cloud Retrieval Fractions are totally different animals between Continuity L3 CLDPROP and MODIS Standard L3 MxD08.

Note 14. Note that towards the end of the Yori Program fine tuning, the Yori Team decided to initialize any Counts array (pixel counts, histogram counts, JH counts) with zero and not FILL. If a user wanted a "well defined" image of the Counts with the FILLS on a global map, they would have to mask the Pixel Counts image with the Fill on the Mean image. The Yori developers decided to do that because "it made more sense to them" to do it that way. This is not how I recommended doing it, but as long as we document this, its ok.

Note 15. A late code change (Jan 2019) restricted the Sensor Zenith Angle to LE 65.5 degrees. This change impacts (mostly) the L3 VIIRS data and helps create a better match between MODIS L3 and

VIIRS L3 in the Continuity Stream. For VIIRS the Sensor Zenith Angle ranges from 0.01 to 70.17 – so this code change removes the outer 4.67 degrees of the Sensor Zenith Angle pixels from VIIRS L3 to better match MODIS. Note that Instrument **Scan** Angle and Sensor **Zenith** Angle are two different animals. VIIRS has an Instrument Scan Angle range of $\pm 56.28^\circ$ so VIIRS views a 3060 km wide swath on the ground at its nominal altitude of 834 km, allowing for complete daily global coverage free of gaps. When I printed out the Sensor Zenith Angle read in from VIIRS CLDPROP_L2 from the SDS “Sensor_Zenith” -- it ranged from 0.01 to 70.17. From Kerry: Scan Angle and Sensor Zenith Angle are in fact different parameters. Scan Angle is defined at the sensor, i.e., the angle of the scan head (pixel detector) itself with respect to nadir (looking straight down). Sensor (or more appropriately View) Zenith Angle is defined at the surface, i.e., the angle between the line from the surface to the sensor and the line straight up from the surface. Due to the curvature of the Earth, the Sensor (View) Zenith Angle will always be larger than the scan angle, with differences increasing towards the edge of scan. By the way, we didn’t actually need UW to help us define the zenith angle cutoff, but we did need them to help clarify what angle is actually reported in the geolocation file (long story). Bottom line is that for both MODIS and VIIRS, the geolocation/L1B/etc. files report View Zenith Angle in the Sensor Zenith Angle variable (the “Sensor” part of that variable name, which might be misconstrued as referring to Scan Angle, threw us off!).

General Notes:

- For sampling VIIRS, one needed to sample in the Pre-Yori step (when creating Yori-compatible files). For VIIRS, it was decided to sample every 4th pixel and 4th line (3km sampling). Note also every 4th row of the sampled array was set to fill – this is to avoid lower quality data from detector 16. The start position was the 2nd column and the 4th row. Every 4th sampled row is set to fill to avoid lower quality data for detector 16. Detectors 1, 2, and 15, 16 have lower quality data.
- Note the internal structure of the files in VIIRS L3 will be slightly different from MODIS L3. In VIIRS, we are using Groups (e.g. Cloud_Optical_Thickness_Liquid) and Variables (e.g. Mean, Sum, etc.), which are part of that group. In MODIS, there are separate SDS’s, whose names are created by appending the statistic suffix name to the parameter prefix name (e.g. Cloud_Optical_Thickness_Mean).
- The Mean and Standard_Deviation statistics in VIIRS L3 are stored in Floating-Point Double-Precision Real in the final gridded output file (by default) – that is, R*8 output is hardcoded in YORI for those statistics. For all the “count” statistics such as Pixel_Counts, Sum, Sum_Squares, Histogram_Counts, and JHisto, they are stored in I*4. There are no issues on file size due to NetCDF4.
- Note that the Fill Value in this output file was hardwired to -999.0

Statistic Definitions:

- n_points = number of L2 input pixels in a 1x1 degree L3 grid cell. (Note YORI does not sample so pixel counts would be in the order of 12,100 (single granule nominal) for each 1x1 deg grid before the sampling code was implemented in the pre-yori file. After the sampling code was implemented, the pixel counts for the 1x1 degree L3 grid cell, for VIIRS are in the order of 800 max (single granule nominal for 3km sampling). (Note that for MODIS it was in the order of 484 max (single granule nominal for 5km sampling), however the modis pixels were slightly larger than viirs (modis pixels are 1x1 km nominal, while viirs pixels are 750x750 m nominal). Note that there are higher counts (17,000 or higher) for VIIRS L3 at the poles due to 1 deg lat/lon grid geometry.
- sum = sum of all the values of the L2 input pixels in a 1x1 degree L3 grid cell (3km sampled).
- sum_squares = sum of the squares of all the values of the L2 input pixels in a 1x1 degree L3 grid cell (sum_squares can be huge numbers).
- mean and standard_deviation are the usual definitions.
- histograms and joint histograms are raw sampled counts as usual.

- Note: MOD08-MODIS Technique Used for Histogram and Joint Histogram binning: The lowest (1st) histogram bin includes L2 data points that fall on either the lowest (1st) bin boundary or the 2nd bin boundary (exactly). All subsequent bins contain points that fall on the higher bin boundary. Any L2 data point that falls outside the specified range of bin boundaries is not counted. This varies slightly from the algorithm used for CLDPROP where the last bin contains points on both boundaries (instead of the first).

Notes on Yori RunTime and Memory Usage:

- Yori aggregation (YORI-AGGR, step 2) in Yori version 1.3.5 was using a lot of memory ~70Gb -- and SIPS cluster was killing any automated jobs. Note that Gridding (YORI-GRID, step 1) works fine and runs fast – it's the Aggregation (YORI-AGGR, step 2) that was the issue. That's why Denis at UW was creating the final L3 files manually on SIPSSCI1 (and not in the automated production stream). But manually he could not create the path and upload to SIPS FTP. This forced Denis to put these files in his local SIPSSCI1 directory. Denis also noted that it takes about 30 hours of wall clock time to create 1 daily (D3) file. However, Paolo and other guys from the SIPS did Yori profiling and have modified the code to significantly reduce memory usage and time processing. So, it is hoped the next Yori version solves our issue, and you will simply grab files from the regular ftp location.

Update: On 19 Feb 2019, Yori version 1.3.6 was released and they improved the run time by 60x. This means D3 runs can be moved from a manual process to an automated process and a single D3 run goes from 30 hours of wall clock time to ½ hour.

Thoughts on My Late Additions (v1.1) of 18 Histogram_Counts:

1. I questioned: Should I add HC for the 4 Angle parameters? Would that be useful? As an initial study of this, I wanted to see what's the range seen in the data?

MODIS Aqua Daily Ranges:
 Solar Zenith 11 to 85
 Solar Azimuth -180 to 180
 After Screen: Sensor Zenith 0 to 65.4
 Sensor Azimuth -140 to 90

MODIS Aqua Monthly M3 Ranges:
 Solar Zenith 21 to 85
 Solar Azimuth -180 to 180
 After Screen: Sensor Zenith 10 to 58
 Sensor Azimuth -125 to 16

VIIRS Daily Ranges:
 Solar Zenith Day 9 to 85
 Solar Az Day -180 180
 After Screen: Sensor Zenith 0 to 65.4
 Sensor Az -122 to 140

VIIRS Monthly M3 Ranges:
 Solar Zenith Day 20 to 85
 Solar Az Day -180 180
 After Screen: Sensor Zenith 17 to 55
 Sensor Az -122 to 20

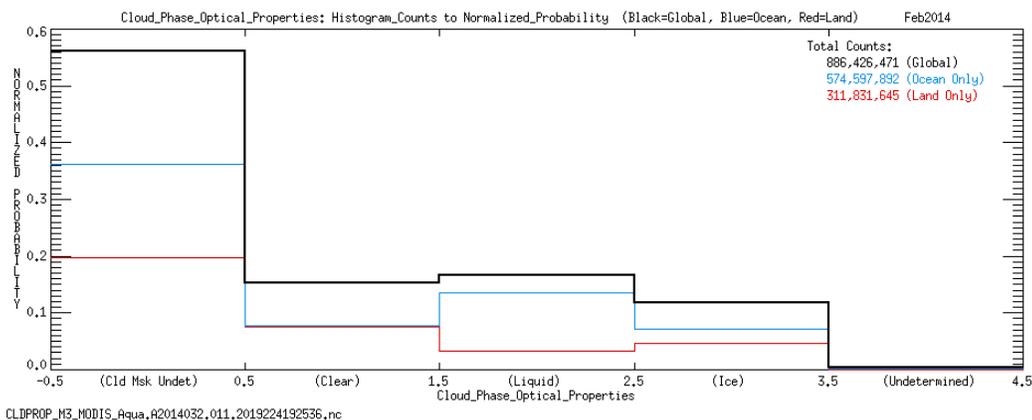
Good Plot Ranges both Platforms and both D3 and M3:

- Solar Zenith Day Good Plot Range in HC (D and M) = 0 to 90
- Solar Az Day Good Plot Range in HC (D and M) = -180 to 180
- After Screen: Sensor Zenith Day Range HC (D and M) = 0 to 65.5
- Sensor Az Day Good Plot Range in HC (D and M) = -140 to 140

Final Decision: No, don't include ... It looks like a too confusing pattern in the images. Not sure HC's of these are valuable or useful

- 2. **Why no Cloud Fraction Histogram Counts?** Note that any L3 CLDPROP Cloud Fraction would have nearly meaningless Histogram_Counts, it would show the number of False 0 as one bar ... and the number of True 1 as the other bar. Not worth adding. This is a result of the wildcard method used to compute Cloud Fractions (CM and COP) in Yori using inputs of T/F fields set up in PreYori.
- 3. **Cloud_Phase_Optical_Properties (CPOP) Histogram_Counts.** Coding a new Cloud_Phase_Optical_Properties (CPOP) Histogram_Counts array in this late beta version (v1.1) of L3 CLDPROP was useful! Even though its semi redundant with the COP_Phase arrays. It showed a bug in the L2 retrieval algorithm code where the L2 code was not properly initializing the L2 Byte CPOP array with fill ("127B") instead it was initializing it with 0's. Therefore for night granules the L2 CPOP array was entirely filled with 0's instead of fill, which led to super high counts in the L3 Hitogram in the 1st bin (0's). Note this CPOP Histogram_Counts array in L3 could be dropped in later versions, however it did have the benefit of showing us this issue in the L2 data. There is one other benefit, it shows direct relative counts of Cloud Mask Undetermined (0) vs Clear (1) vs Liquid (2) etc. While the COP_Phase arrays have 2 categories of clear and the L/I/U counts shown in separate Histograms, so you don't get a sense of relative counts very easily in the HC's.

Benefits of a CPOP HC in L3. What this CPOP HC array has that the Individual COP_Phase HC arrays don't is 1.) it combines all the clears, 2.) it combines the CLDY and PCL, 3.) it shows the Cloud Mask Undetermined (this category was messed up from a bug in L2 where the CPOP L2 array was inadvertently initialized with 0 instead of FILL -- so the nighttime granules of CPOP in L2 are filled with 0) 4.) it shows the relative population of each of these cats in comparison with each other on a single plot so I believe it provides a better (easier to interpret) on the fly QA tool to monitor things related to CM health, Clears, and Phase Categories.



CLDPROP_M3_MODIS_Aqua_A2014032_011.2019224192536.nc